

## Children Programmed for Obesity

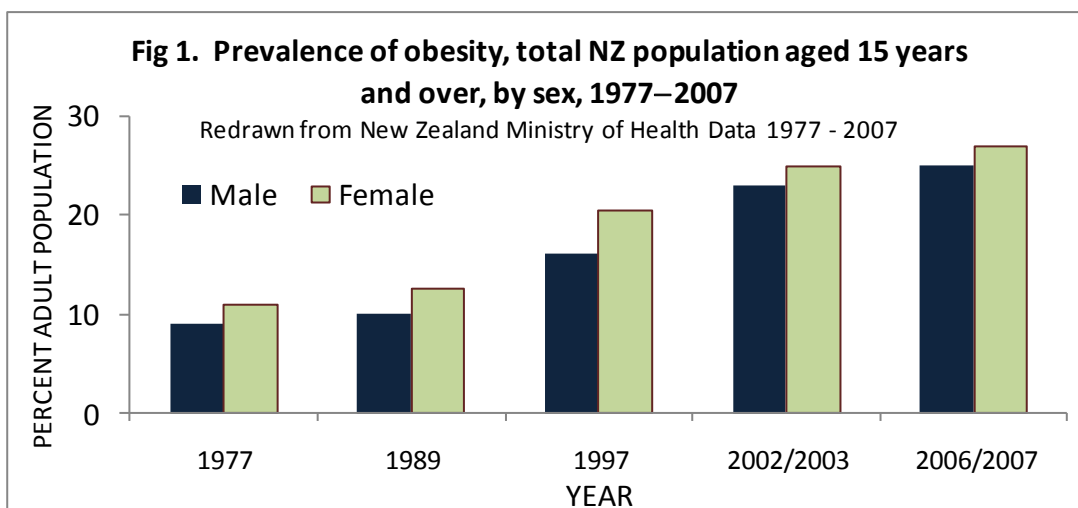
A Resource for New Zealand Schools

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### **GLOBESITY – The 21<sup>ST</sup> CENTURY WORLD OBESITY EPIDEMIC**

New Zealanders are getting fatter and we are in good company. Obesity is increasing throughout the developed world, and, sadly, New Zealand is in the leading group of nations. We have the 3<sup>rd</sup> highest rate of obesity in the OECD, a group of 30 developed nations from across the world. This is one bronze medal we really don't want for New Zealand!

The number of adults in New Zealand who are obese has more than doubled in the past 30 years. 25% of adults in New Zealand are now obese. That is 1 in every 4 people. Sadly, it is going to get worse. In 2007, 8% of New Zealand children aged between 5 and 14 were obese. We know that obese children have a higher risk of becoming obese adults, so we can expect our adult obesity rates to be even higher in the future.



### **How did New Zealand get so good at this?**

The Ministry of Health believe the main factors that have led to this increase in obesity are changes in our diet and lifestyle. We do less exercise than we used to, and we eat too much high energy food and drink!

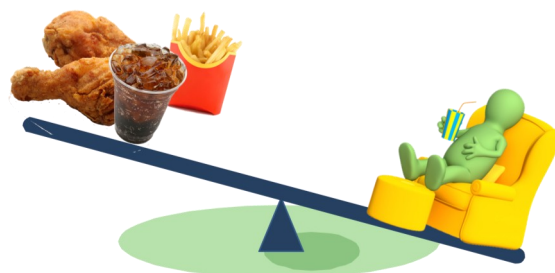
**However this is not the total picture.**

*As well as changes in lifestyle, scientists are discovering that there is a strong link between a mother's diet during pregnancy and the risk of her child becoming obese as an adult. The nutritional environment that the fetus experiences in the womb is impacting on future health risks for the child.*

Our early life environment affects our **risk** of obesity in adulthood



The University of Auckland's Liggins Institute and New Zealand's National Research Centre for Growth and Development are contributing to world-leading research in this field. Working with scientists around the world, they are trying to find out more about this. This understanding will help reduce obesity and the diseases that obesity leads to.



## WHAT IS OBESITY?

Obesity is a measure of how much body fat a person has. People who are obese put themselves at greater risk of disease. Obesity cannot be measured simply by the weight of a person. A tall lean person may weigh more than a shorter fatter person, so obesity measures have to consider both height and weight.

A tool called the **BODY MASS INDEX (BMI)** is used to measure levels of obesity. BMI is calculated by dividing your mass in kilograms by your height in metres squared.

$$BMI = \frac{\text{your mass in kg}}{\text{the square of your height (m}^2\text{)}}$$



A person is described as obese when they have a BMI greater than 30 for Pakeha NZ, Asian and other populations or greater than 32 for Māori and Pasifika populations.



Sarah is a Year 13 girl. She is 165cm tall and weighs 65kg.

$$\text{Sarah's BMI} = \frac{65}{1.65 \times 1.65} = 2.7225$$

*Sarah's BMI = 23.9 (Healthy Weight)*

Do these people have a healthy BMI?



BMI Value	Underweight	Healthy Weight	Overweight	Obese
Māori & Pacific	<18.5	18.5–26	26–32	>32
Pakeha/ European	<18.5	18.5–25	25–30	>30
Asian & Indian	< 18.5	18.5–23	23–25	>25

**Male A** is a 39-year-old European male.

- Height = 187.2cm
- Weight = 106.0 kg

**What is his BMI?**

**Who has the healthy BMI?**

**Male B** is a 37-year-old European male.

- Height = 180.5 cm
- Weight = 93.0 kg

**What is his BMI?**

**Task 1:**  
What is Obesity?

***Like many broad measurement tools, BMI only gives an estimate of body fat.***

Muscle weighs more than fat. This means that a person who is very muscular, such as a member of the All Blacks or a runner or netball player, will have a higher BMI than a person of the same height who is not so muscular.

The actual amount of body fat can only be measured by a body composition scan. Scientists at The University of Auckland's Liggins Institute can measure body composition very accurately using a **Dexa Scan**. The scan measures the percentage of fat and lean tissue, and the bone density. This is more accurate than BMI because it shows the difference between lean tissue (muscle) and fat tissue.



**Male A** is a 39-year-old NZ European/Pakeha male who has a BMI of 30.2 ( $\text{kg}/\text{m}^2$ ).

**Using BMI he is classified as obese.**

However, the data from his Dexa scan shows that his body is composed of only **12.1% fat**.

**With only 12.1% body fat he is NOT obese.**

In this case BMI is not an accurate measure of obesity.

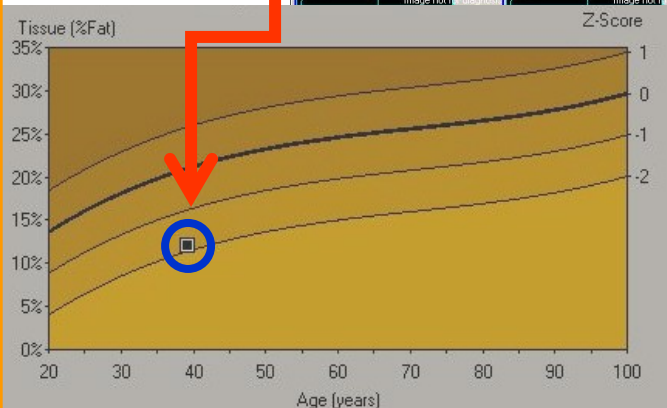
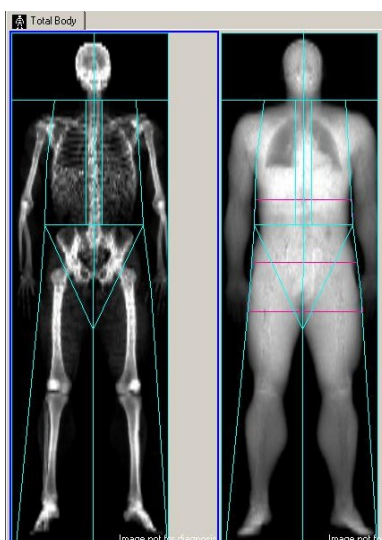


Fig. 2. Amount of fat as a % of total body tissue in a 39-year-old NZ European/Pakeha male.

**Male B** is a 37 year old NZ European/Pakeha male who has a BMI of 28.5 ( $\text{kg}/\text{m}^2$ ).

**Using BMI he is classified as overweight.**

However the Dexa scan shows that over a third of his body is fat!

His body tissue is composed of **34.2% fat**.

In this case BMI has underestimated the body composition.

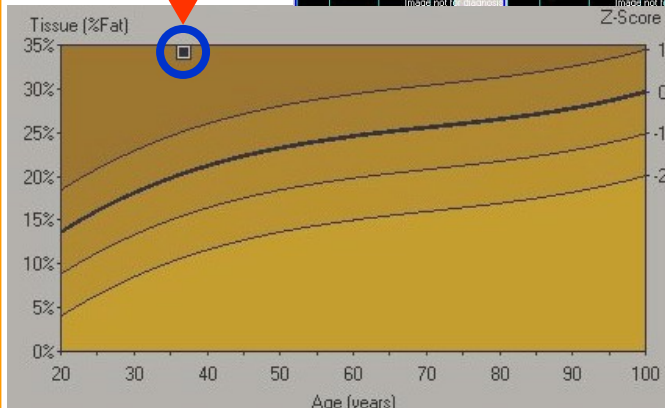
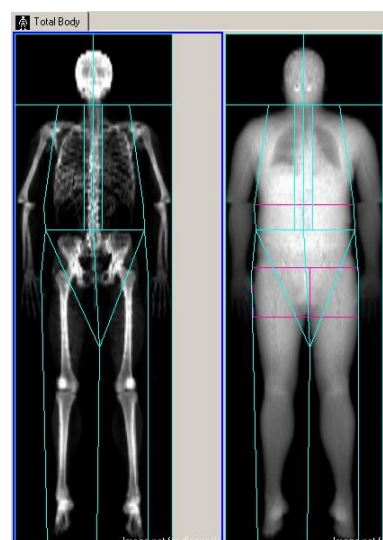
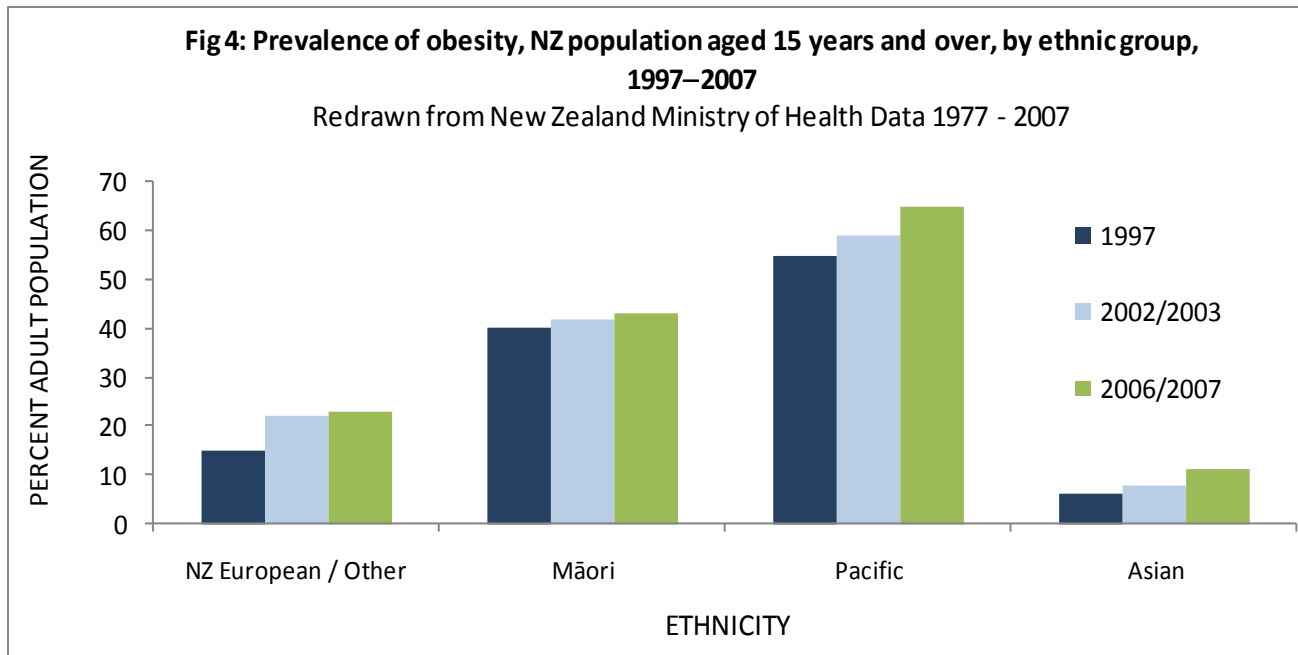


Fig. 3. Amount of fat as a % of total body tissue in a 37-year-old NZ European/Pakeha male.

**The most accurate way to measure obesity levels in the population would be to scan everyone!**  
**However that is not practical, so the BMI, used with discretion, is a valid measure of obesity.**

## Obesity Rates in Māori and Pacific Populations

Māori and Pacific peoples have the highest rates of obesity in New Zealand. The graph below shows that in 2007 65% of Pacific adults and 42% of Māori adults were obese. Pacific children are at least 2.5 times more likely to be obese than children in the total population. Māori children are approximately 1.5 times more likely to be obese than children in the total population. This suggests the total number of obese Māori and Pacific adults will get even greater in the future – which means many more people suffering from diseases like Type 2 diabetes.



## Why all the fuss about obesity? Can't we just make bigger seats!



Scientists know there are many non-communicable diseases that are directly linked to obesity. Being obese means a person has a higher chance of being affected by these diseases. **Non-communicable diseases are diseases that you cannot catch – they develop slowly over time.**

A communicable disease is one you can catch – like a virus or a bacterial infection.

**Type 2 diabetes is a non-communicable disease, and is a major health issue for New Zealand.**

The number of people diagnosed with diabetes in New Zealand has increased from 80,000 adults in 1996 to 120,000 in 2006. New diagnoses are predicted to rise by 63% per year over the next decade (*Ministry of Health, 2007*).

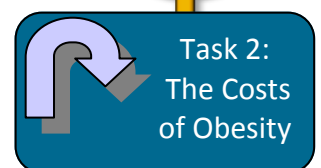
**How many people in New Zealand are expected to be diagnosed with diabetes by 2016?**

### Disease Risk Linked to Obesity:

- Diabetes
- High blood pressure
- Heart disease
- Osteoarthritis
- Gallbladder disease
- Cancer
- Liver disease
- Sleep apnoea
- Social and psychological problems

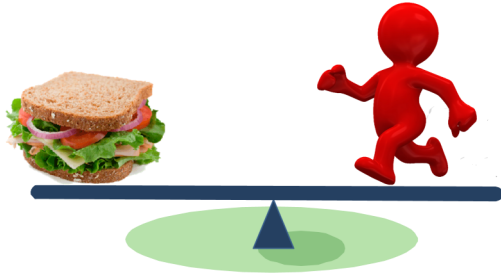


In 2006 the cost of primary health care in New Zealand linked to Type 2 diabetes was \$444 million per year. If nothing is done to improve ways of preventing diabetes, this is predicted to reach \$1,800 million (2006 value \$'s) per year over the next 15 years (*Price WaterhouseCoopers, 2007*).





## WHAT DO SCIENTISTS KNOW ABOUT THE REASONS FOR OBESITY?



HEALTHY DIET AND EXERCISE



POOR DIET AND NOT ENOUGH EXERCISE

RISK OF OBESITY

We know that eating **too much food**, or food that is **high in fat**, and **not getting enough exercise** will definitely **increase the risk** of a person becoming obese.

FOOD and ACTIVITY are DIET and LIFESTYLE FACTORS;  
they are part of our personal environment.

RISK is the chance of something happening.  
The higher the risk – the more likely it is to happen.

We can all **REDUCE** our **RISK** of **OBESITY** by having a  
**healthy diet and active lifestyle NOW.**

Our body composition (healthy, overweight or obese) is one part of our phenotype.  
Our **phenotype** is a description of what we **look like** and the state of  
our **health and wellbeing**.

Our **phenotype** is affected by our **genes AND** our **environment**.  
Diet and lifestyle are part of our environment.

Scientists know that as well as our environment now, the  
environment that we experienced in early life **ALSO**  
affects our risk of obesity and related diseases.

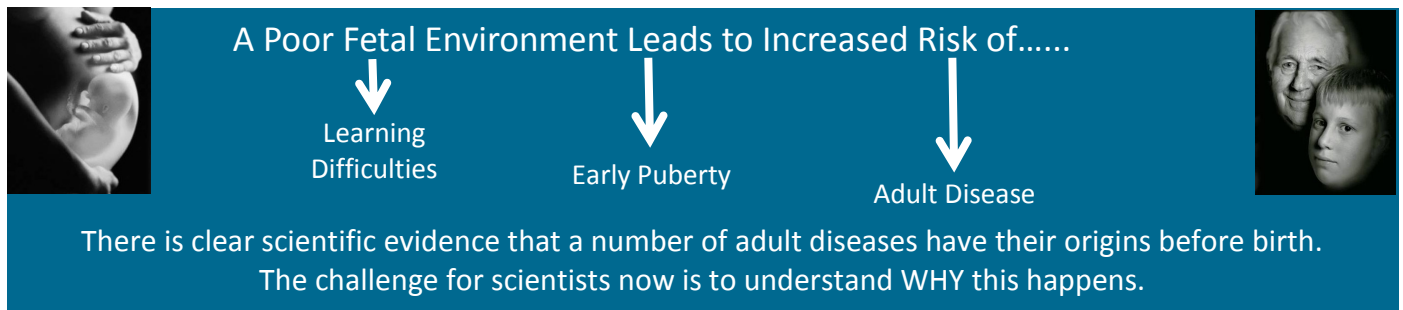
**YOUR PERSONAL RISK** of **OBESITY**  
is influenced by  
your diet and lifestyle now  
**AS WELL AS**  
the diet your mother had when she  
was pregnant with you.

Our early life  
environment  
affects our  
**risk** of  
obesity in  
adulthood



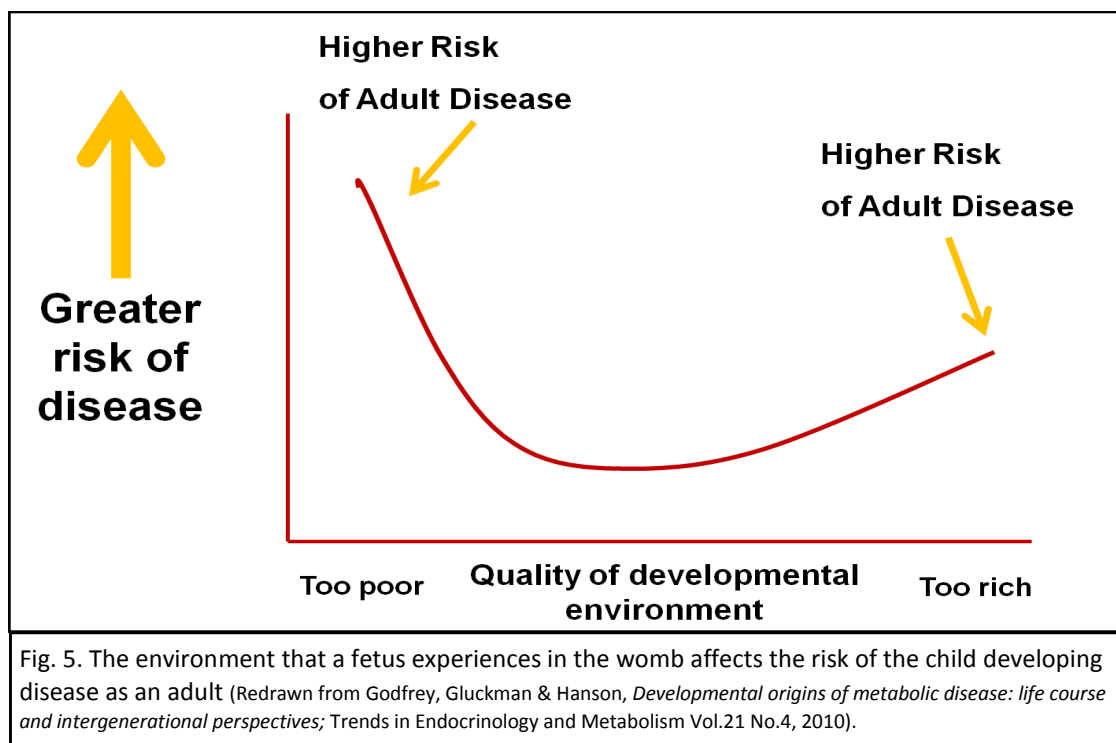
Task 3:  
At Risk of  
Obesity

## CHILDREN PROGRAMMED FOR OBESITY

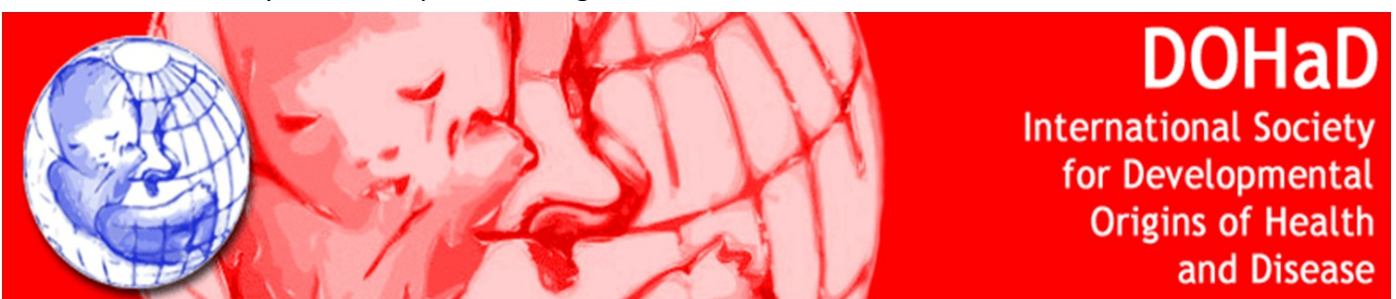


Scientists around the world are working together to understand how the environment we experience during pregnancy affects our risk of developing non-communicable diseases such as diabetes and heart disease in later life.

Professor Sir Peter Gluckman from the University of Auckland and Professor Mark Hanson from the University of Southampton are leading scientists in this group. They have shown that a mother's body influences her child's development from the moment of conception. **Her body composition, diet and lifestyle teach her baby about the world in which the mother lives. This will influence the child's risk of disease for the rest of their life.** An early-life environment that is either too poor or too rich will **increase the risk** of the child becoming obese and developing diseases such as Type 2 diabetes.



By understanding why some people have a higher risk of developing non-communicable diseases such as Type 2 diabetes, scientists can learn more about how to reduce the risk of disease and suffering. Scientists from around the world share their knowledge and findings about this work through the International Society for Developmental Origins of Health and Disease.



## EVIDENCE: HOW DO WE KNOW?

Medical research scientists and doctors are interested in why some people get non-communicable diseases such as **heart disease** and **Type 2 diabetes**.

They ask **QUESTIONS** and search for **EVIDENCE** to find **ANSWERS**.

An **OBSERVATION** by scientists helped unravel the **EVIDENCE** that means we now know that our **early-life environment** influences our **risk of diseases** such as heart disease and Type 2 diabetes.

University of Southampton scientists Professors David Barker and Clive Osmond noticed that when they compared maps showing infant mortality rates (deaths in children) at the beginning of the 20th century and rates of heart disease in adults in the 1970's – the maps looked remarkably similar. Did this mean that there was a link between early-life environment and heart disease in adults?

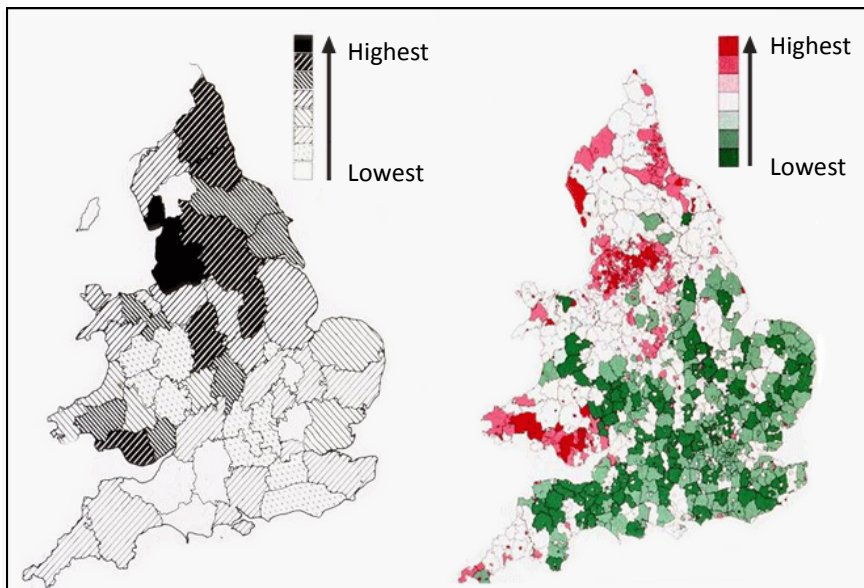
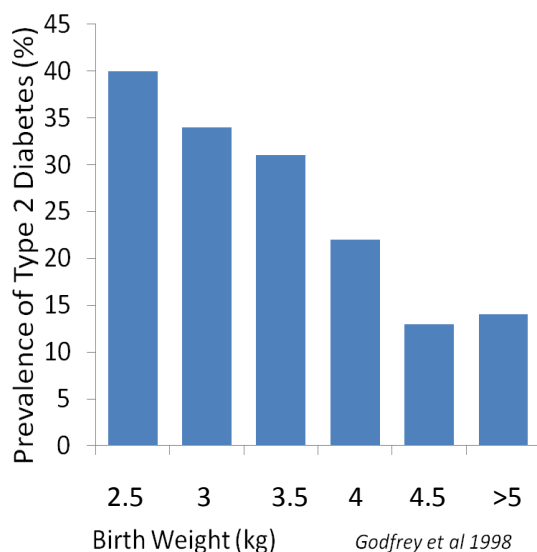


Fig. 6. Infant mortality rates/1000 births in England and Wales from 1901–1910. Fig. 7. Coronary heart disease in men in England and Wales from 1968–1978.

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Professors Barker and Osmond set about trying to find out whether their hypothesis was correct. In 1986 they found birth records from a region called Hertfordshire where from 1911 onwards, a woman by the name of **Ethel Burnside**, Lady Inspector of Midwives, had made sure that very accurate records of births and the early years of children's lives were kept by midwives and health visitors. In the early 20<sup>th</sup> century, around 1 in 10 children died before they reached their 1<sup>st</sup> birthday and many who survived had poor health as adults. The midwives records were kept to try to improve the health of the children (Barker, 2003).

Fig. 8. Prevalence of Type 2 diabetes vs. birth weight in 370 men aged 60 years old

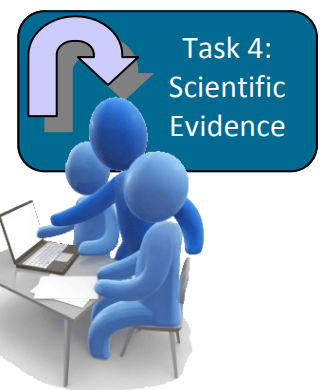


Professor Barker and his team used these health records to trace 15,000 men and women born in Hertfordshire before 1930. They discovered that 3000 were already dead – half from heart disease or related disorders. They also found it was more likely that those who had died had been small at birth.

The team then contacted those that were still alive, told them about what they were doing and why, and asked them if they would like to help by taking part in the study.

What they discovered was people who were smaller at birth were more likely to have high blood pressure, Type 2 diabetes, and a number of other common characteristics that made them overall less healthy. The graph on the left shows the results for Type 2 diabetes.

You can find out more about the Hertfordshire Study at <http://www.mrc.soton.ac.uk/herts/>



## USING A SCIENTIFIC MODEL TO EXPLAIN WHY

### *Why are people who have a poor environment in the womb more likely to get Type 2 diabetes?*

The team at the University of Southampton found evidence that in human populations, people who are born small are more likely to get Type 2 diabetes. Scientists at the University of Auckland's Liggins Institute are working to find out why this is.

Our early life environment affects our **risk** of obesity in adulthood



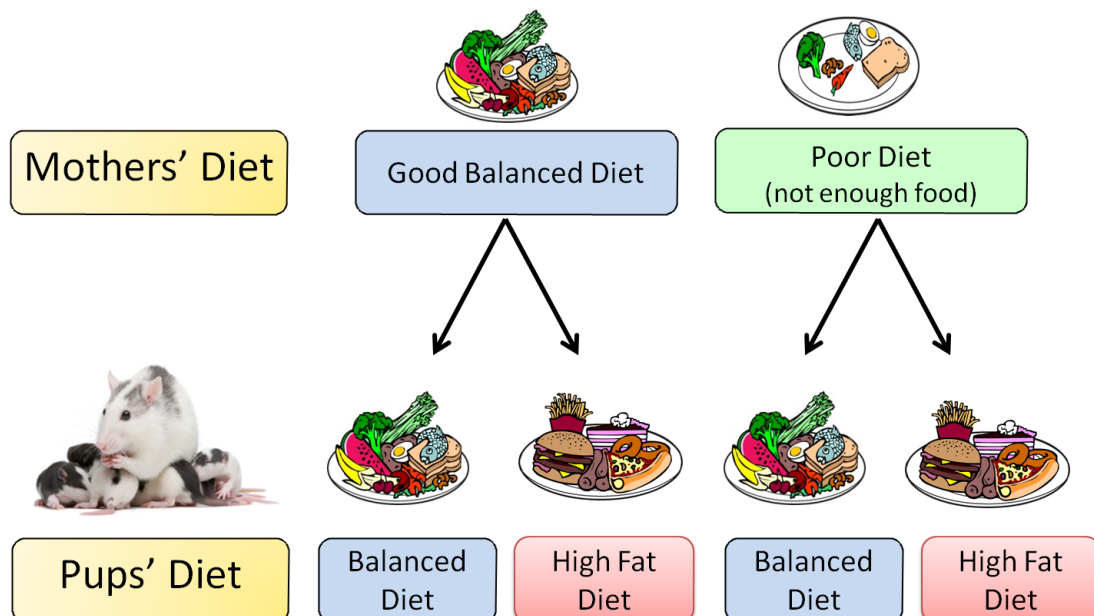
The scientists could not use humans to do this – it would not be ethical to ask a mother to go on a diet while she was pregnant – especially as we know it will cause a greater risk of disease as that baby grows up. Instead, scientists use small animals as models to answer the question. This allows scientists to study not only what is physically observed (phenotype) but also what is happening at a cell level, and hopefully work out how to reverse it. Strict ethical regulations are adhered to in the design and carrying out of research using animal models. Many treatments for diseases such as asthma, cancer, heart disease, diabetes and many more are developed using small animal models. Drugs, such as Ventolin that asthmatics use daily, and many painkillers have been developed with the aid of small animal models.

#### **Aim:**

**To find out whether what a mother eats when she is pregnant affects the risk of the baby developing Type 2 diabetes when it grows up.**

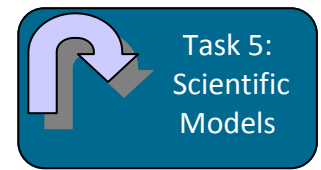
#### **Method:**

- Pregnant mother rats were put on two different diets, either a healthy diet or a diet with not enough food.
- When the baby rat pups were born the mothers fed them milk for 22 days.
- After 22 days the rat pups were then split into two groups and put on either a healthy balanced diet or a high-fat diet as they grew up.
- As the rat pups grew, the scientists measured what they **ate**, their **weight** and how much **exercise** they did.
- DEXA scans were taken to measure body fat and blood tests were taken to measure health and show whether the rats would go on to **develop Type 2 diabetes or high blood pressure**.

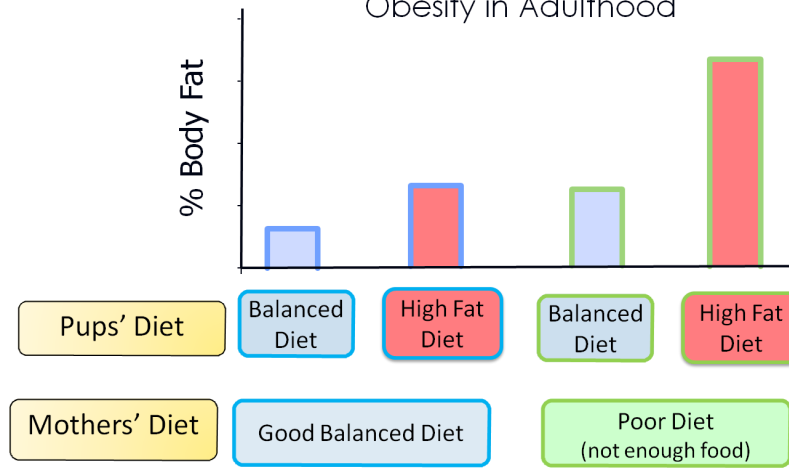




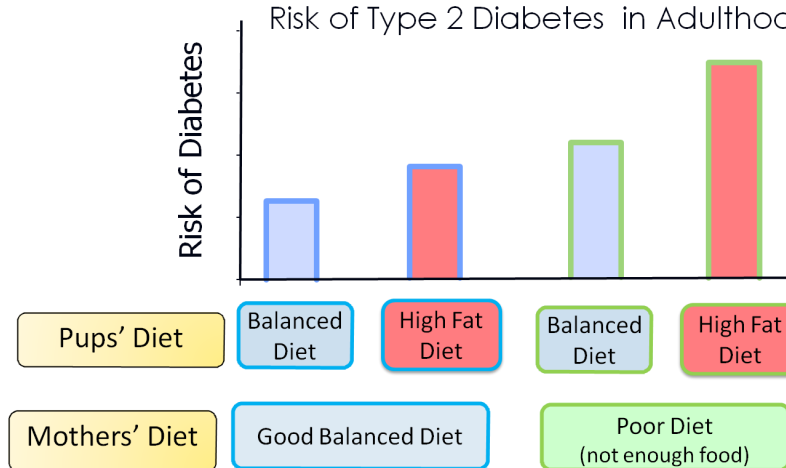
## Results:



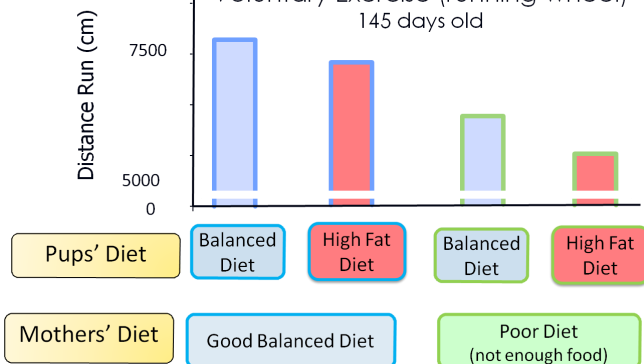
Effect of Diet Before and After Birth on Obesity in Adulthood



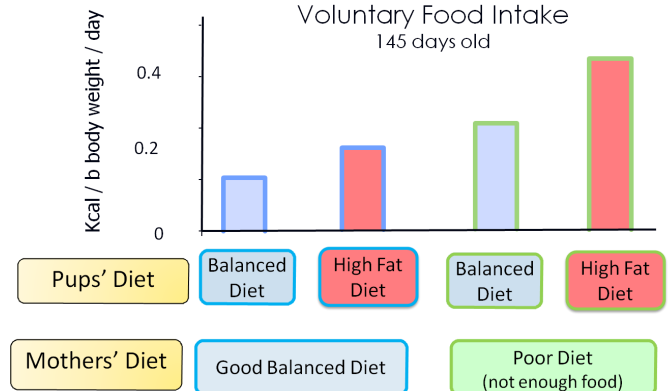
Effect of Diet Before and After Birth on Risk of Type 2 Diabetes in Adulthood



Effect of Diet Before and After Birth on Voluntary Exercise (running wheel) 145 days old



Effect of Diet Before and After Birth on Voluntary Food Intake 145 days old



## Conclusion:

The rat pups of the mothers who did not eat a good diet during pregnancy were born smaller.

When these rat pups grew up:

- they were **fatter** than the other rats
- they did **less exercise** and **ate more** than the other rats
- they had a **higher risk of Type 2 diabetes** than the other rats.

Eating a high-fat diet after birth made these worse – the pups were even fatter, did even less exercise and were even more likely to get Type 2 diabetes.

The scientists confirmed that mothers eating a poor diet when they are pregnant is **ONE** reason for having a **higher risk** of having Type 2 diabetes. Their next job is to find out **WHY** this happens.

## Finding out why

The scientists did more tests and looked at sampled of DNA from the rats. They wanted to work out how the phenotype is changing.



They found out that:

- the mothers' diet is NOT changing the sequence of DNA base pairs in the offspring (pups)
- the mothers' diet IS CHANGING which genes get turned on or off in the offspring.

The scientists think that because the environment (diet) in the womb is different to the diet that the pup experiences when it is born, the genes that are being turned on do not match the environment that the pup is growing up in.

This MISMATCH between the environment in the womb and the environment in the world is the reason why the pups grow up with a high risk of developing Type 2 diabetes.



**Scientific evidence can tell us that a COMBINATION of our environment in the womb AND our DIET AND LIFESTYLE as we grow up and as adults, will affect our risk of developing Type 2 diabetes.**

### Useful websites for Students

The New Zealand Social Report 2010 <http://www.socialreport.msd.govt.nz>

This site has all the up to date data on rates of obesity in New Zealand.

Diabetes New Zealand <http://www.diabetes.org.nz>

This site is good for explaining the difference between Type 1 and Type 2 diabetes, finding out about the symptoms of diabetes, risk factors for diabetes, and the recommended diet for diabetics.

Diabetes in New Zealand <http://www.moh.govt.nz/diabetes>

This is a Ministry of Health website that has a lot of good information about diabetes in New Zealand.

New Zealand Food and Nutrition Guidelines

<http://www.moh.govt.nz/moh.nsf/indexmh/nutrition-foodandnutritionguidelines>

This is a Ministry of Health website with information about nutrition for New Zealanders.

Five Plus a Day <http://www.5aday.co.nz>

This website gives information about eating the recommended 5+ servings of fruit and vegetables each day.

Full references and supporting resources for teachers can be found on the LENSscience Website.

**Thanks to the University of Southampton MRC Lifecourse Epidemiology Unit**

*Original Illustrations page 8–9 – Sophie Reissner.*

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[http://lens.auckland.ac.nz/index.php/Diabetes\\_Teacher](http://lens.auckland.ac.nz/index.php/Diabetes_Teacher)